Activity Title: One Fish, Two Fish

Subject (Focus/Topic): Scientific Inquiry and Marine Population dynamics

Grade Level: 7 or 8

Average Learning Time: (3) 50 minute periods

Lesson Summary:

Students will simulate participation in long term scientific research project to better understand how scientists collect marine population data to discover interactions between marine organisms and their environment.

Overall Concept (Big Idea/Essential Question):

Marine scientists use technology to research fish populations to learn their size and understand their movements. These results influence resource management policies regarding these organisms which are important economically for both food production and recreational fishing industries.

Specific Concepts (Key Concepts):

Marine organism behaviors; methods and technology scientists use to collect population data

Focus Questions (Specific Questions):

What environmental factors influence the movements of populations of fish?

Describe how animal behaviors may impact their population numbers.

In what ways has use of technology improved scientists' ability to gather data on marine fish populations?

Objectives/Learning Goals:

- Given a set of 4 cards showing fish found in the Florida Keys National Marine Sanctuary, students will be able to identify the fish and provide the common name with 100% accuracy.
- Students will be able to describe one technique using technology to collect information on fish population numbers and movements.
- Given a table of actual data on fish populations collected by marine scientists, students will be able to identify at least 2 trends in the data and use it to predict a future condition of the population.
- Students will be able to use data from the table to support at least one identified trend.

Background Information:

- Familiarize yourself with the teaching materials and the scientific research techniques using the materials listed in the lesson and at the Teacher at Sea blog.
- Evaluate the specialized vocabulary used in the lesson to determine the support your own students will need to understand the lesson goals. Amend the list as you see necessary.
- Practice narration to the Power Point so that the presentation is paced to keep students engaged. Several of the slides are animated to show what transpired.
- Some exposure to scientific method is plus. However, if your students are not familiar with how scientists solve problems this activity can act as an informal introduction.
- If you feel you need additional background information on the science related to this lesson it is available at:

http://www.nps.gov/ever/naturescience/upload/DRTORNA5YrFINALComplete04092012LoRes.pdf
pages 18-23 specifically.

Common Misconceptions/Preconceptions:

Students may assume that the fish pictured on the activity cards are all the same size relative to each other as they appear on the cards; they are not. Grouper in particular can be quite large.

Students may not truly appreciate how much technology has improved scientists' ability to understand difficult to observe phenomenon such as the number of fish moving through an area of the ocean.

Students may expect there to be a single correct answer to the questions in One Fish, Two Fish however there are multiple interpretations of the information collected. As more data is collected over time the better scientists can predict outcomes in marine population sizes and movements.

Materials:

Day 1 Materials:

If you choose to make a word wall: Construction paper, markers, scissors, dictionary or other digital or print resources for students to define key words from the PowerPoint presentation.

World Map (optional)

Day 2 Materials:

Several days before this lesson, make a set of 30 fish cards for each activity group. Use card stock paper and laminate them to save time and materials in the future. For easy distribution, store each set of cards in its own envelope labeled with the group number for each activity group.
(See file: MuttonSnapperLab.TeacherKey.NOAA.TAS.2012.pdf)

Make copies of the activity. Students can complete the paper individually however, the group can work together to contribute responses and complete one activity paper per group and assign a group grade. (See file: MuttonSnapperLab.Student.NOAA.TAS.2012.pdf)

Make 1 copy of Data Table C for each class to post their findings. (See the Teacher Key file above)

Technical Requirements (for all lessons):

- Ability to project a PowerPoint presentation and provide narration of the notes for each slide
- If students have access to computers with Internet capability they use the Teacher at Sea blog entry as an alternative exploration. Direct them to: http://teacheratsea.wordpress.com/2012/07/30/susan-kaiser-ready-set-science-july-29-2012/

Teacher Preparation:

Day 1 Lesson Preparation:

1. Preview the PowerPoint and become familiar with the teacher notes. As you review the presentation identify additional vocabulary words your students may need to know the meanings of in order to understand the content material. You may see the need to add more words to the content vocabulary listed. (Optional)
2. Practice the presentation of the PowerPoint so that it will take about 15 minutes. This pace will keep students focused. If they have questions during the presentation they may opt to write them down; they may be answered during the remaining presentation.
3. Obtain a world map and be able to recognize if your students can correctly locate the study site if asked. (optional)

Day 2 & 3 Lesson Preparation:

1. If students are not familiar with scientific names be ready to give a brief explanation describing how organisms are classified. Closely related organisms share the same first name or genus while organisms that can mate and reproduce an offspring that can also reproduce share the same second name or species. This information will facilitate students' use of the fish cards and introduces the scientific study of taxonomy.
2. Use your professional judgment to decide if you will assign students to create groups of 3-4 to work as a team or some other method to create groups.
3. Decide if you will assign tasks within the group or allow your students to self-monitor the completion of the activity tasks. Suggestions on assigned tasks are listed in "Lesson Procedure Day 2 Exploration, Option" which follows.

Keywords:

Mutton Snapper, acoustic tag, spawning aggregation, spawning corridor, detected

Pre-assessment Strategy/Anticipatory Set (Optional)

See below

Lesson Procedure:

Day 1 Lesson:

Engagement: What are some of the challenges scientists face when studying marine organisms?

Use Think, Pair, and Share to lead a class discussion of the question above.

Transition to the PowerPoint presentation to introduce students to the techniques and technology used to collect information on marine organisms. Assess your students' familiarity with the vocabulary presented and scientific names which will be used in the next lesson.

Optional: Depending on your students' vocabulary background, build a list of word wall vocabulary to define and use in the next lesson. Pairs of students can define a term, present it and post the vocabulary meanings. In some cases the words can be defined by context others will need to be found in the science book or dictionary. Create a word wall to display these terms and definitions which will be used throughout the three class meetings.

Exploration:

Locate the research site on a world map and allow students to become familiar with the region.

At home, students can explore further by visiting the Teacher at Sea blog entry via the Internet. This entry can also serve as an introduction to the activity if the PowerPoint presentation is not an option. The data collection method students will simulate in the activity is described. Find it at:

http://teacheratsea.wordpress.com/2012/07/30/susan-kaiser-ready-set-science-july-29-2012/

Day 2 Lesson:

Engagement: As a scientist you need to know your study subject. Take some time in your group to learn the characteristics of economically & recreationally important marine fish by previewing today's activity.

Distribute activity sheets to students in groups of 3-4 as you have assigned.

Exploration:

Encourage student group to work together to preview the simulation activity and learn the identifying features of the target fish in the project. They will simulate by hand what scientists are able to do using modern technology. Circulate to each table to listen for understanding. Can students identify a fish and

name its common name easily? Encourage them to refer to the chart during the activity as they practice this skill.

Preview the problem and procedure. Check for understanding of the task and clarify any questions.

Option: Assign tasks within the table group. Examples are: a recorder to tally detected fish, a reader to help the group follow the steps of the activity, a dealer to set up the cards at the start and count them at the end and a leader to check the tallies, report the group findings and lead the analysis discussion. You can allow the students to divide the task themselves or let each group choose between the assigned roles you suggest and their own plan to carry out the activity. Choose the option that you think will serve your students best.

Explanation:

After the students have completed the activity, lead a brief discussion. Ask: How close to reality is this data collection simulation? Allow students to share their thoughts. Some may think it isn't even close. However, visual fish counts are still used but are very time intensive and expensive. They also have limitations such as only counting fish that are present when the divers are down. Scientists today have multiple tools to learn the behaviors of marine species as described in the Power Point presentation.

By the end of the discussion make sure students understand that the activity uses hand counting of fish to simulate what the receivers are recording every day, only more efficiently. The data includes not only individual fish but the depth they are swimming and the date and time they pass by all of which can be studied by the marine scientists. Encourage them to discuss all the possibilities that explain the numbers of Mutton Snapper and complete questions 1-3 of their activity sheet.

Set up for the next and final lesson of evaluating the actual data collected. This can be achieved several ways: through continued discussion of the results analysis so far, visiting the Teacher at Sea blog (if they haven't already) or looking up articles related to the research found at the links below.

http://teacheratsea.wordpress.com/2012/07/30/susan-kaiser-ready-set-science-july-29-2012/

http://floridakeys.noaa.gov/scisummaries/mutton.pdf

http://floridakeys.noaa.gov/scisummaries/tortugasfish2011.pdf

Students can do some independent research on their own at home using home computers. Alternatively, you can provide photocopies of the mutton snapper article and ask students to read it and contribute in class as homework.

Day 3 Lesson:

Engagement: Use the strategy chosen at the end of lesson two as a segue into the data analysis lesson. Discussion or a review of what students read can be an excellent starting point to include what do scientists do with the information they learn.

Elaboration:

Distribute the actual data on Mutton Snapper in the study area. Allow students a few minutes to review the data and look for trends again. Using what they have learned previously students will work as a science team to identify evidence that supports their recommendation to the resource managers about the regulations in the area. These recommendations can be summarized as key points using bullets and identifies the data as evidence. Ask them to prepare a short oral statement to share with the class of a key piece of evidence and their recommendation.

The spokesmen for each table group take turns orally presenting their interpretation of one evidence example and their recommendation. This allows every group to present their best point to the class as a whole group. This can continue until all groups have spoken or no new information is being shared.

Evaluation:

Now that they have completed the activity ask them to answer the question at the beginning of the activity.

What patterns exist in movements of recreationally and commercially important fish between foraging grounds and spawning aggregation sites in the Dry Tortugas?

Compare their responses to the information you have all learned and read about while completing this lesson.

Assessment and Evaluation:

Activity Sheet Responses:

Students' collective responses to the questions in the lab provide the assessment of the skills used in the activity. Compare their contributions to the notes provided in the Teacher Key and your own interpretations of the information provided.

Students should be able to acknowledge that a smaller subset of information makes predictions for future outcomes more difficult to predict.

Students should be able to identify the environmental factors that influence the fish populations in the region including season and moon phase.

Students should be able to acknowledge how technology improves the ability of scientists to collect information in a more efficient manner and to gain a better understanding of marine life populations and behaviors.

Activity Observations:

As you observe and circulate around the room during the activity to help groups keep moving through the activity you can also assess the level of engagement of students. They should be able to identify the fish and name them.

As groups make their oral statements of the key evidence at the end of class the overall group success can also be evaluated at a formative assessment of their ability to work together to finish the task as well as answering the key questions for the activity.

Standards:

Next Generation Science Standards (NGSS)

Performance Expectation

MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Disciplinary Core Ideas

LS1.B: Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

LS2.A: Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)

LS2.C: Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

Engineering and Science Practices

Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)

Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4)

Scientists are employed by colleges and universities, business and industry, hospitals, and many government agencies. Their places of work include offices, classrooms, laboratories, farms, factories, and natural field settings ranging from space to the ocean floor. 1C/M4

Crosscutting Concepts

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

Ocean Literacy

Principal #2: The ocean and humans are inextricably interconnected.

D. 4 Responsible fishery practices prevent the overfishing of target species, thus sustaining the ecosystem.

Principal #5: The ocean supports a great diversity of life and ecosystems

B.11 Organisms in the ocean exhibit an amazing variety of life cycles…some undergo long seasonal migrations to mate and have young.

Principal #7: The ocean is largely unexplored.

A.6 Data gathered from advanced technology enables scientists to make better estimations and predictions of physical and biological phenomena.

B. Ocean exploration and the analysis of ocean systems require collaboration and sharing of information on many different levels; local, regional, national and international.

State Science Standards (Nevada) 2008

N.8.A.1 Students know how to identify and critically evaluate information in data, tables, and graphs.

N.8.A.3 Students know different explanations can be given for the same evidence.

N.8.A.6 Students know scientific inquiry includes evaluating results of scientific investigations, experiments, observations, theoretical and mathematical models, and explanations proposed by other scientists.

N.8.B.1 Students understand that consequences of technologies can cause resource depletion and environmental degradation, but technology can also increase resource availability, mitigate environmental degradation, and make new resources economical.

N.8.B.2 Students know scientific knowledge is revised through a process of incorporating new evidence gained through on-going investigation and collaborative discussion.

L.8.C.4 Students know inter-related factors affect the number and type of organisms an ecosystem can support.

Additional Resources:

Southern Nevada Regional Professional Development Program provides digital resources for the Nevada State Science Standards at http://www.rpdp.net/sciencetips_v3/NatureOfScience.htm

Ocean Literacy http://oceanliteracy.wp2.coexploration.org/

Reference for the ongoing marine research in the Florida Keys National Marine Sanctuary is available at:

http://floridakeys.noaa.gov/scisummaries/mutton.pdf

http://floridakeys.noaa.gov/scisummaries/tortugasfish2011.pdf

Extension Resources:

Please note that these lessons were implemented in conjunction with a year-long observation activity of a single location in the native plant garden on our school campus. The activity was called "One Spot" and parallels the marine scientist's data collection of the type of fish that swim past one of the receivers on the ocean floor. Students used journals to record observations of their "One Spot" in the native plant garden and note changes in the plants as the seasons changed. Observing the responses of organisms to seasonal changes in the environment is known as Phenology. Citizen Science describes the participation of community members in gathering information about natural phenomenon and contributing these observations to archives used by trained scientists. Observations of the plants and their growth stages were contributed to a citizen science project called Project Budburst. If you would like to learn more about how to incorporate phenology or to engage students in contributing data to citizen science projects in your instruction consult the websites listed below.

Phenology Resources:

1. Use a wheel format to record observations over a period of time as is shown at this resource http://www.earthzine.org/2011/02/14/phenology-wheels-earth-observation-where-you-live/
2. Help to set up observation projects for Middle School students http://www.usanpn.org/education/5-8
3. Plant bloom observations: http://www.budburst.org/

Citizen Science Resources:

1. http://www.scientificamerican.com/citizen-science/ for an overview of citizen science
2. http://www.birds.cornell.edu/citsci/projects focuses on observing backyard birds
3. http://www.thedailygreen.com/environmental-news/latest/citizen-science-47121401#slide-1 an extensive list of citizen science projects that you can connect to.
4. http://www.calacademy.org/science/citizen_science/ describes local opportunities in the San Francisco, CA area. There may be similar programs available in your locale.

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Creation Date: May 1, 2013

Dear Colleague,

My hope is that you find this lesson useful to meeting your teaching goals. I have tried to provide enough background for novice teachers as well as enriching resources for the pros. Enjoy helping your students experience what marine scientists are learning through the collaborative efforts of National Oceanic and Atmospheric Association (NOAA), Florida Keys National Marine Sanctuary (FKNMS) and the Florida Fish and Wildlife Commission (FWC)

Cheers,

Susan Kaiser, NBCT
Reno, NV

If you are short on time this summary will help give you an overview.

This lesson introduces the research of NOAA and Florida Fish and Wildlife Marine scientists who are collaborating to learn about commercially important marine fish in the region south of the Florida Keys. These scientists are gathering population and migration pattern data to inform management decisions within the Florida Keys National Marine Sanctuary (FKNMS) and the Dry Tortugas. The lesson incorporates an introductory PowerPoint presentation outlining the multiple techniques used to collect information on marine species. The students then participate in a simulated data collection activity using randomly drawn fish cards to represent the species swimming past the acoustic receivers. This activity allows students to mimic the sampling techniques used by the actual scientists who are responsible for collecting and monitoring these marine resources. The students will collaborate with other groups in class or in multiple classes to amass a data set representative of the one collected by marine researchers. The data can be analyzed for patterns and compared to past actual data. The lesson puts scientific processes into practice as students identify and record the types of fish that are "detected," relate it to past population numbers which are analyzed for trends. Students can interpret their findings to evaluate marine use procedures and policies and assist management agencies such as the FKNMS in determining future management plans just as the NOAA, FKNMS and FWC scientists are doing.

Teacher Key

Day 1:

Possible responses to the discussion question include:

The ocean is large making it difficult to find marine organisms. Organisms could be in deeper water than humans can easily observe. Weather conditions such as hurricanes may present problems for ships. Humans need special equipment to stay underwater very long making observation times short or infrequent. Marine organisms could be harmed in the process of catching them or finding them. Some marine organisms are dangerous or poisonous. Additional student responses may also be generated and should be allowed if reasonable.

Use the best responses to segue into the PowerPoint introduction.

Day 2:

Teacher notes begin on the next page.

Name _____Teacher Key_____ Date_____Period_____

One Fish, Two Fish

In this activity you will collaborate with other groups in your class as you take on the role of marine scientist. You will simulate collecting data about tagged fish and their movements. By working together you will have a better understanding of the number and type of fish using this habitat. Your group will record the tagged fish swimming past the receiver located in a spawning corridor of the Florida Keys National Marine Sanctuary (FKNMS) near the Dry Tortugas. This information about important fish species provides evidence to support your recommendations to the marine resource managers. They must strike a balance between protecting and preserving these marine resources.

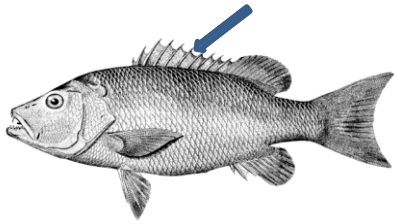
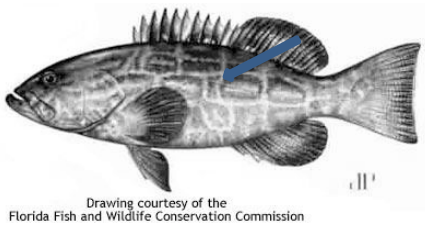
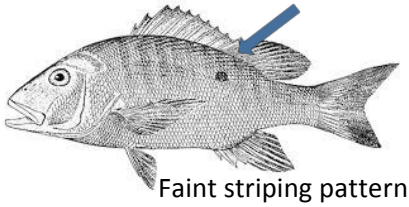
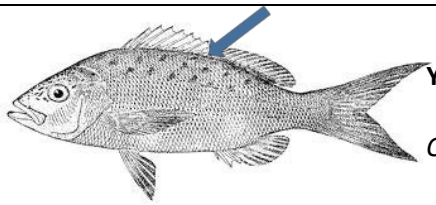
Problem: What patterns exist in movements of recreationally and commercially important fish between foraging grounds and spawning aggregation sites in the Dry Tortugas?

Materials: set of fish cards, coin, pencil, class data table (1 copy for each class), FKNMS Research Results

Procedure

1. Study the marine fish shown below and note their unique characteristics. Some are marked by an ⟸. If you can you identify their differences and name each species you are ready to begin.
2. Your teacher will provide a set of these fish cards to your group. You will use them to simulate how marine scientists collect data. **Note**: An (**X**) mark on the fish abdomen shows they have been tagged using an acoustic device implanted inside their abdomen.
3. Spread the fish cards out on the table top **with the blank side up.** These cards represent the fish swimming in the sample area. Place a coin near the center of the cards. This represents the receiver which detects the acoustic tag signal.
4. Choose a card at random; turn it over. Identify the species using the characteristics below. If the fish shown on the card has the acoustic tag or (**X**), use a tally to record it in Data Table A. It has been counted or "detected." Remember, unmarked fish are not tallied since they have no acoustic tag implanted.
5. Repeat step 4 above, taking turns around the table until you have turned over a total of 15 cards and have completed the blanks in Data Table A.
6. Calculate the number of fish of each type your group "detected" in Data Table B. Post your results Data Table C.

Commercially and recreationally important fish species of the Florida Keys National Marine Sanctuary (FKNMS) near the Dry Tortugas.

<table>
<tr>
<td> 
Gray Snapper
Lutjanus griseus
Uniform color pattern</td>
<td> 
Drawing courtesy of the
Florida Fish and Wildlife Conservation Commission
Black Grouper
Mycteroperca bonaci
Rounded fins</td>
</tr>
<tr>
<td> 
Mutton Snapper
Lutjanus analis
Faint striping pattern dorsal side (back)</td>
<td> 
Yellowtail Snapper
Ocyurus chrysurus
Longer, forked tail</td>
</tr>
</table>

Created by Susan Kaiser, NOAA TAS 2012; Pine Middle School; Reno, Nevada

DATA TABLE A: Number of fish species detected near spawning aggregation sites in the FKNMS Dry Tortugas.

Group or Table #	Mutton Snapper *L.analis*	Gray Snapper *L. griseus*	Black Grouper *M. bonaci*	Yellowtail Snapper *O. chrysurus*
	Numbers will vary	for each table group		

DATA TABLE B: The total number of each species your group detected. Report these totals on the Class Data Table C

Mutton Snapper *L.analis*	Gray Snapper *L. griseus*	Black Grouper *M. bonaci*	Yellowtail Snapper *O. chrysurus*
	Numbers will vary	for each table group	

Analyze and Conclude

In a simple way, the process you just finished shows how scientists can learn about marine species. Luckily they do not count fish by hand. Instead, by developing different technology tools, marine scientists can collect a large amount of data over longer time periods, in deeper water and in conditions unsafe for divers. For this NOAA/FKNMS research project, scientists surgically implant small device called an acoustic tag inside a fish's abdomen. This tag emits a signal that is detected by receivers placed on the ocean floor in the spawning corridor. This allows tagged fish movements to be documented and any patterns identified. When large numbers of fish gather at a particular location in order to reproduce it is called a spawning aggregation. By knowing when and where fish will congregate to spawn, resource managers can recommend policies that protect these fish at this critical time in their life cycle.

Interpreting Data:

Read and evaluate the actual data that NOAA/FKNMS scientists have collected for the Dry Tortugas study site. Use this information to answer these questions marine scientists are asking.

1. Analyze the data collected on the Mutton Snapper (*L. analis*) counted at Stations 2 & 12 during this ongoing study. Identify any patterns or trends that you noticed in the space below.

   Answers will vary. Some possible responses include:
   - The number of fish generally increase over time especially more recent data.
   - Some years are shown as a range without much change
   - Most of the information is collected in the summer months
   - Data shown is from 3 different research studies at the same location
   - Accept other reasonable suggestions

2. List 2 or 3 environmental factors that might explain what caused the trends that you noticed.

   Answers will vary. Some possible responses include:
   - Time of year
   - Moon phase
   - Spawning behaviors of the fish
   - Water temperatures or other qualities
   - Fishing impacts
   - Accept other reasonable suggestions

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3. Use the trends in the data to estimate the numbers of Mutton Snapper at this location next summer. It may help you to graph the numbers to make the prediction. Specify the data or graph characteristics as evidence to support your prediction.

   You may require students to make the graph if they need to practice this skill; this is your option. Students may predict that the fish numbers will continue to increase. The graph may help them to identify a specific number. Students may also respond that more years of data are needed to make this prediction given that the technology use is relatively new. Accept answers that the data supports and not a single isolated number.

Application:

Research on fish populations in the Tortugas Ecological Reserve (TER) of the Florida Keys National Marine Sanctuary (FKNMS) began in 1999 and continues today. New fishing regulations established in 2001 made the area a "NO Take Zone." This means that fishermen are not allowed to catch fish or even anchor in this area, at all. Now it is time for resource managers to review the impacts of this regulation. They will need your recommendations for the future plan. Work with your team to review the all the data and synthesize a list of key points. The marine resource managers will consider your findings as they review the impacts of the NO Take Zone regulation. Include at least 3 examples of evidence you have to support your reasoning and provide the resource managers the documentation they need.

Recommendation:

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Evidence:

- _____

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- _____

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- _____

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CLASS DATA TABLE C:

Total number of each fish species detected by receivers near spawning aggregation sites in the FKNMS Dry Tortugas.

Group or Table #	**Mutton Snapper** ***L.analis***	**Gray Snapper** ***L. griseus***	**Black Grouper** ***M. bonaci***	**Yellowtail Snapper** ***O. chrysurus***
1				
2				
3				
4				
5				
6				
7				
8				
Grand Total				

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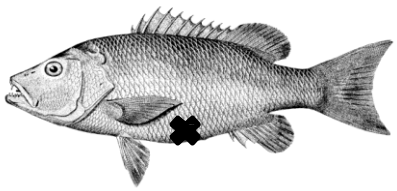
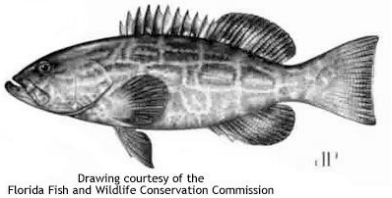
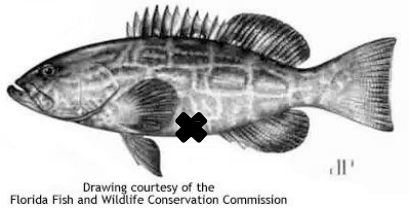
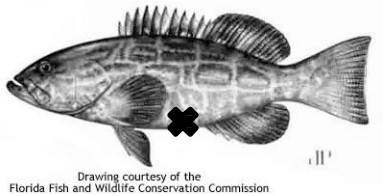
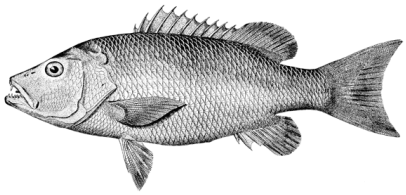
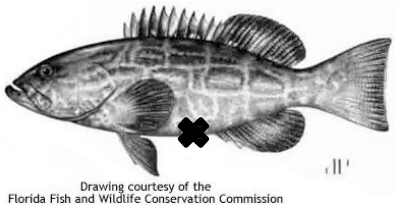


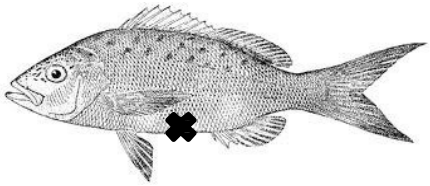

Drawing courtesy of the
Florida Fish and Wildlife Conservation Commission

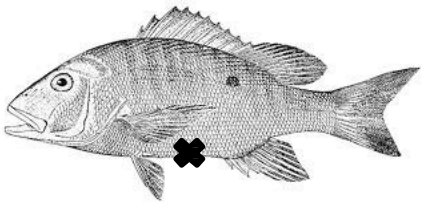

Drawing courtesy of the
Florida Fish and Wildlife Conservation Commission

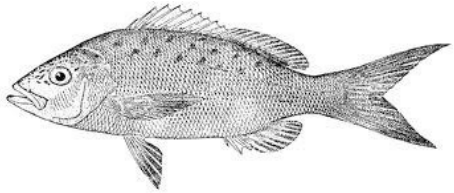

Drawing courtesy of the
Florida Fish and Wildlife Conservation Commission

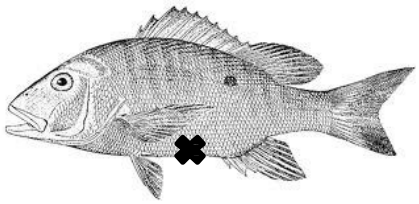


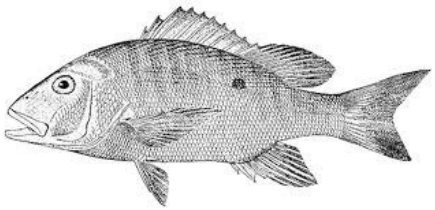

Drawing courtesy of the
Florida Fish and Wildlife Conservation Commission

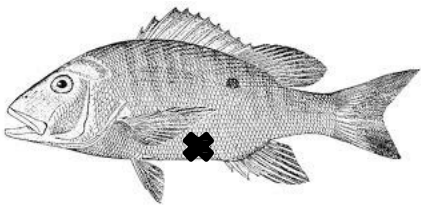


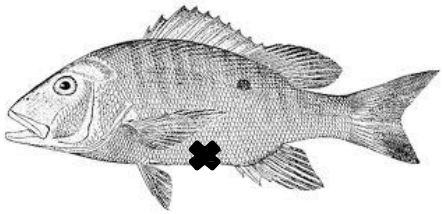


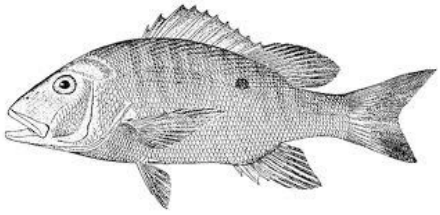


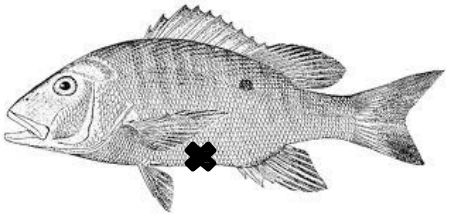












Drawings of fish obtained at:

http://ccma.nos.noaa.gov/products/biogeography/gom-efh/lma.aspx mutton, gray and yellowtail snapper

http://www.fla-keys.com/fishing/localfish/blackgrouper.htm black grouper

Cumulative Observations of Mutton Snapper (Lutjanus analis) on Riley's Hump, Tortugas South Ecological Reserve, FKNMS

Date	Station	Numbers Observed	Moon phase
28 May-1 June 1999	visual survey	1 fish in 3 of 11 dives	Full moon on May 30*
31 July-3 Aug. 2000	visual survey	1 fish in 5 of the 6 dives	New moon on July 30*
17 July 2001	2	10	3 days before new moon*
27 May 2002	2	75-100	1 day after full moon*
15 June 2003	2	75-100	1 day after full moon*
15 June 2003	12	200+	1 day after full moon*
4 July 2004	12	300	2 days after full moon*
3 July 2007	12	100+	3 days after full moon**
12 June 2009	From 14:15-17:15 hours	~4000	5 days after full moon***

Asterisk indicates research source

* Burton, ML et al. Preliminary Evidence of Increased Spawning Aggregations of Mutton Snapper (Lutjanus analis) at Riley's Hump. Tortugas South Ecological Reserve. Fish Bull 103:404-410.

** Mike Burton's trip

***Florida Fish and Wildlife Commission (FWC) current study.

Name_____Date_____Period_____

One Fish, Two Fish

In this activity you will collaborate with other groups in your class as you take on the role of marine scientist. You will simulate collecting data about tagged fish and their movements. By working together you will have a better understanding of the number and type of fish using this habitat. Your group will record the tagged fish swimming past the receiver located in a spawning corridor of the Florida Keys National Marine Sanctuary (FKNMS) near the Dry Tortugas. This information about important fish species provides evidence to support your recommendations to the marine resource managers. They must strike a balance between utilizing and preserving these marine resources.

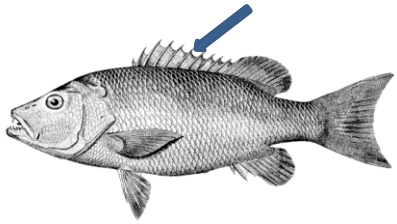
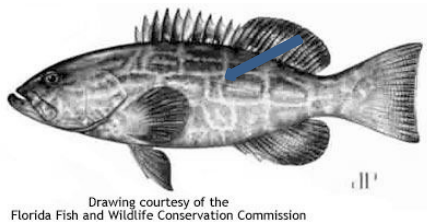
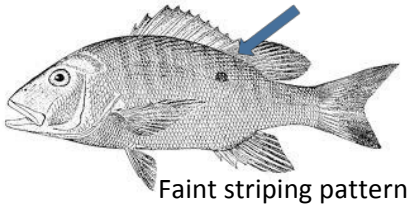
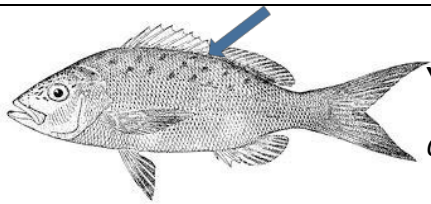
Problem: What patterns exist in movements of recreationally and commercially important fish between foraging grounds and spawning aggregation sites in the Dry Tortugas?

Materials: set of fish cards, coin, pencil, class data table, FKNMS Research Results

Procedure

1. Study the marine fish shown below and note their unique characteristics. Some are marked by an ⬅. If you can you identify their differences and name each species you are ready to begin.
2. Your teacher will provide a set of these fish cards to your group. You will use them to simulate how marine scientists collect data. **Note**: An (**X**) mark on the fish abdomen shows they have been tagged using an acoustic device implanted inside their abdomen.
3. Spread the fish cards out on the table top **with the blank side up.** These cards represent the fish swimming in the sample area. Place a coin near the center of the cards. This represents the receiver which detects the acoustic tag signal.
4. Choose a card at random; turn it over. Identify the species using the characteristics below. If the fish shown on the card has the acoustic tag or (**X**), use a tally to record it in Data Table A. It has been counted or "detected." Remember, unmarked fish are not tallied since they have no acoustic tag implanted.
5. Repeat step 4 above, taking turns around the table until you have turned over a total of 15 cards and have completed the blanks in Data Table A.
6. Calculate the number of fish of each type your group "detected" in Data Table B. Post your results in Data Table C.

Commercially and recreationally important fish species of the Florida Keys National Marine Sanctuary (FKNMS) near the Dry Tortugas.

<table>
<tr>
<td> 
Gray Snapper
Lutjanus griseus
Uniform color pattern</td>
<td> 
Drawing courtesy of the Florida Fish and Wildlife Conservation Commission
Black Grouper
Mycteroperca bonaci
Rounded fins</td>
</tr>
<tr>
<td> 
Mutton Snapper
Lutjanus analis
Faint striping pattern dorsal side (back)</td>
<td> 
Yellowtail Snapper
Ocyurus chrysurus
Longer, forked tail</td>
</tr>
</table>

Created by Susan Kaiser, NOAA TAS 2012; Pine Middle School; Reno, Nevada

DATA TABLE A: Number of fish species detected near spawning aggregation sites in the FKNMS Dry Tortugas.

Group or Table #	**Mutton Snapper** ***L.analis***	**Gray Snapper** ***L. griseus***	**Black Grouper** ***M. bonaci***	**Yellowtail Snapper** ***O. chrysurus***

DATA TABLE B: The total number of each species your group detected. Report these totals on the Class Data Table C

Mutton Snapper ***L.analis***	**Gray Snapper** ***L. griseus***	**Black Grouper** ***M. bonaci***	**Yellowtail Snapper** ***O. chrysurus***

Analyze and Conclude

In a simple way, the process you just finished shows how scientists can learn about marine species. Luckily they do not count fish by hand. Instead, by developing different technology tools, marine scientists can collect a large amount of data over longer time periods, in deeper water and in conditions unsafe for divers. For this NOAA/FKNMS research project, scientists surgically implant small device called an acoustic tag inside a fishes' abdomen. This tag emits a signal that is detected by receivers placed on the ocean floor in the spawning corridor. This allows tagged fish movements to be documented and any patterns identified. When large numbers of fish gather at a particular location in order to reproduce it is called a spawning aggregation. By knowing when and where fish will congregate to spawn, resource managers can recommend policies that protect these fish at this critical time in their life cycle.

Interpreting Data:

Read and evaluate the actual data that NOAA/FKNMS scientists have collected for the Dry Tortugas study site. Use this information to answer these questions marine scientists are asking.

1. Analyze the data collected on the Mutton Snapper (*L. analis*) counted at Stations 2 & 12 during this ongoing study. Identify any patterns or trends that you noticed in the space below.

_____

_____

_____

2. List 2 or 3 environmental factors that might explain what caused the trends that you noticed.

_____

_____

_____

Created by Susan Kaiser, NOAA TAS 2012; Pine Middle School; Reno, Nevada

3. Use the trends in the data to estimate the numbers of Mutton Snapper at this location next summer. It may help you to graph the numbers to make the prediction. Specify the data or graph characteristics as evidence to support your prediction.

_____

_____

_____

Application:

Research on fish populations in the Tortugas Ecological Reserve (TER) of the Florida Keys National Marine Sanctuary (FKNMS) began in 1999 and continues today. New fishing regulations established in 2001 made the area a "NO Take Zone." This means that fishermen are not allowed to catch fish or even anchor in this area, at all. Now it is time for resource managers to review the impacts of this regulation. They will need your recommendations for the future plan. Work with your team to review the all the data and synthesize a list of key points. The marine resource managers will consider your findings as they review the impacts of the NO Take Zone regulation. Include at least 3 examples of evidence you have to support your reasoning and provide the resource managers the documentation they need.

Recommendation:

_____

_____

_____

_____

Evidence:

- _____

_____

_____

_____

- _____

_____

_____

_____

- _____

_____

_____

Reef Fish Sampling in the Florida Keys

by: Danielle Morley

Edited for use at Pine Middle School
by: Susan Kaiser
NOAA Teacher at Sea 2012

Florida Fish and Wildlife Conservation Commission
Fish and Wildlife Research Institute
South Florida Regional Laboratory
2796 Overseas Hwy; Suite 119; Marathon, FL 33050

Coral reef managers around the world have similar questions:

- Are the coral reefs healthy?
- What are the threats impacting coral reefs?
- Are fish populations increasing or decreasing?
- Are management actions successful?
- Is a marine protected area working?
- What is the level of satisfaction of the resource users?

This presentation gives a overview of some current research projects in the Keys. It also prepares you for a simulation activity in class.

Finfish Research Group

Florida Fish and Wildlife Conservation Commission

- Law Enforcement
- Freshwater Fisheries Management
- Hunting and Game Management
- Marine Fisheries Management
- Fish and Wildlife Research Institute
  - Lobster Research
  - Sea Turtle Research
  - Coral Research
  - Conch Research
  - Stone Crab Research
  - Fisheries Dependent Research
  - Finfish Research

Commercially and Recreationally Important Species

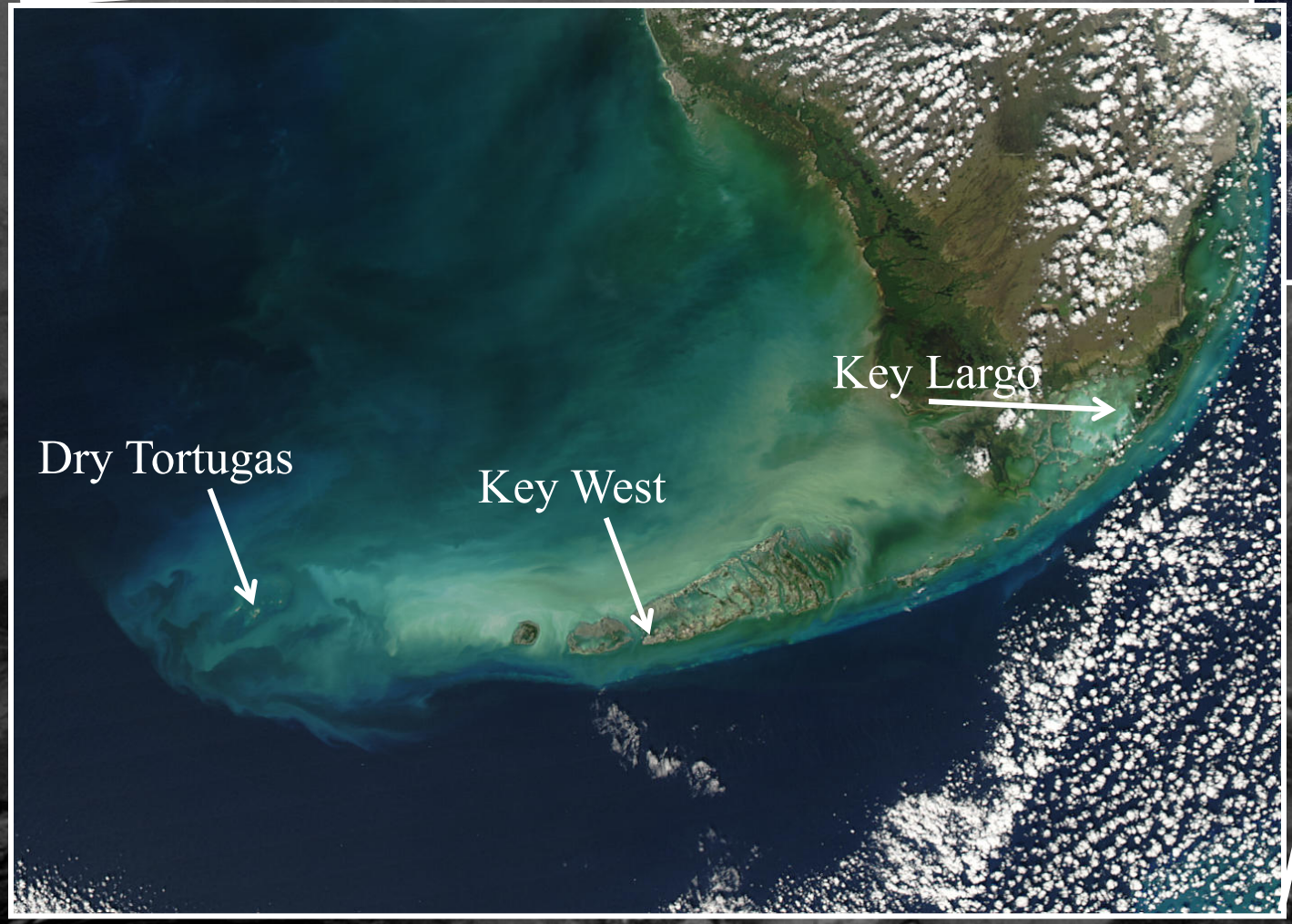
Lutjanus analis
mutton snapper

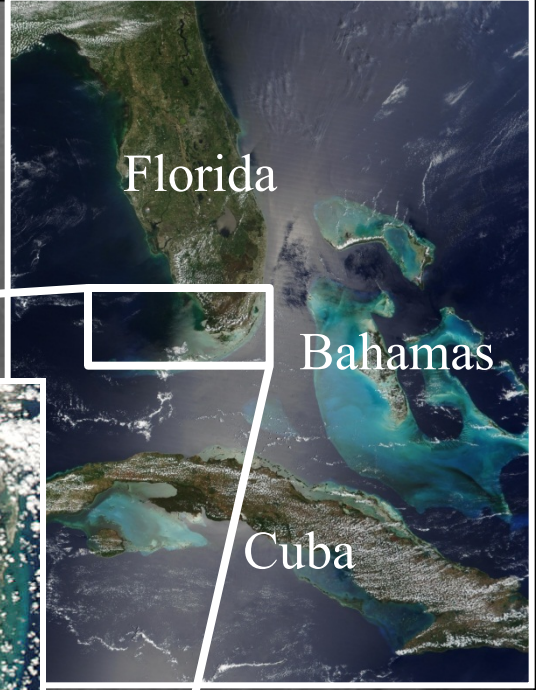
Lutjanus griseus
gray snapper

Ocyurus chrysurus
yellowtail snapper

Mycteroperca bonaci
black grouper

Location, location, location!



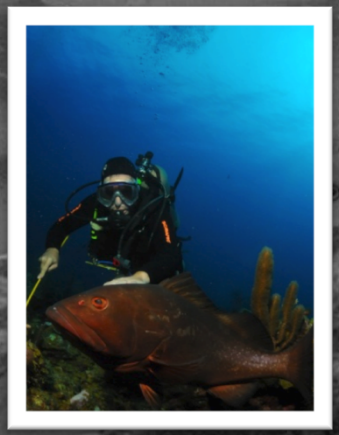


Overview of the Finfish Program

Several different programs study fish populations throughout the entire Florida Keys reef track and covering various life stages.

Seining Program

Reef Visual Census



Spawning Aggregation Studies

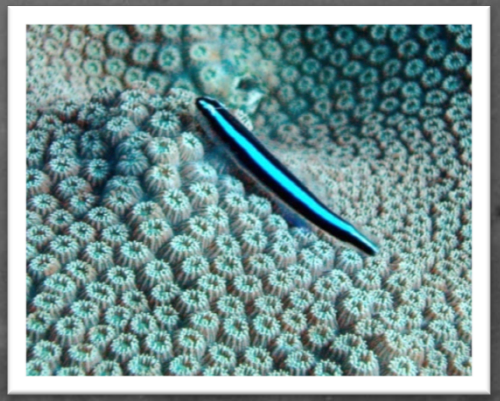
Seine Survey

Scientists count the fish found in shallow water

Typical catch

Mutton snapper

Reef Visual Census (RVC)



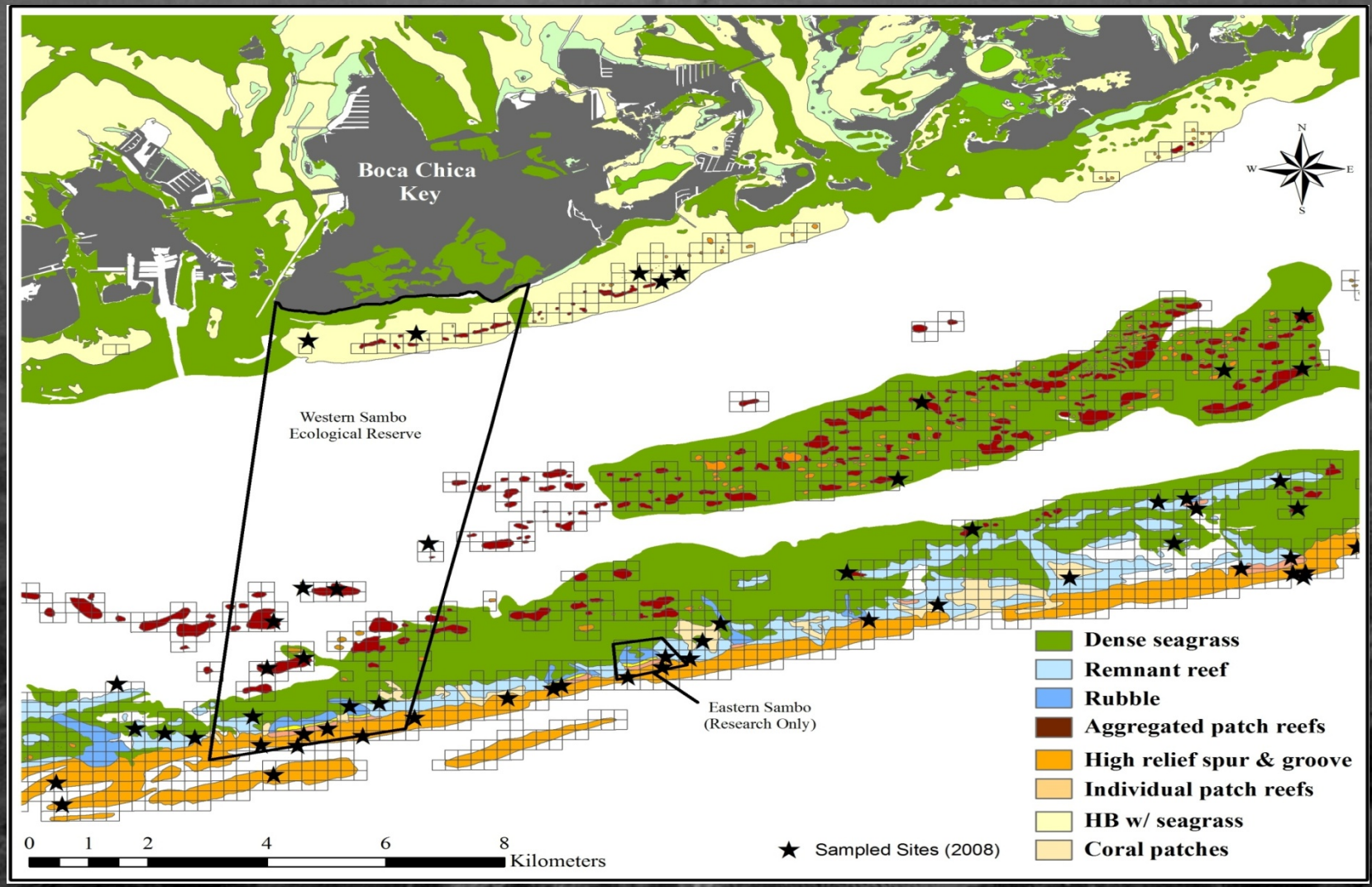
Goal: Estimate population & community make up

Method: Stratified Random Sampling

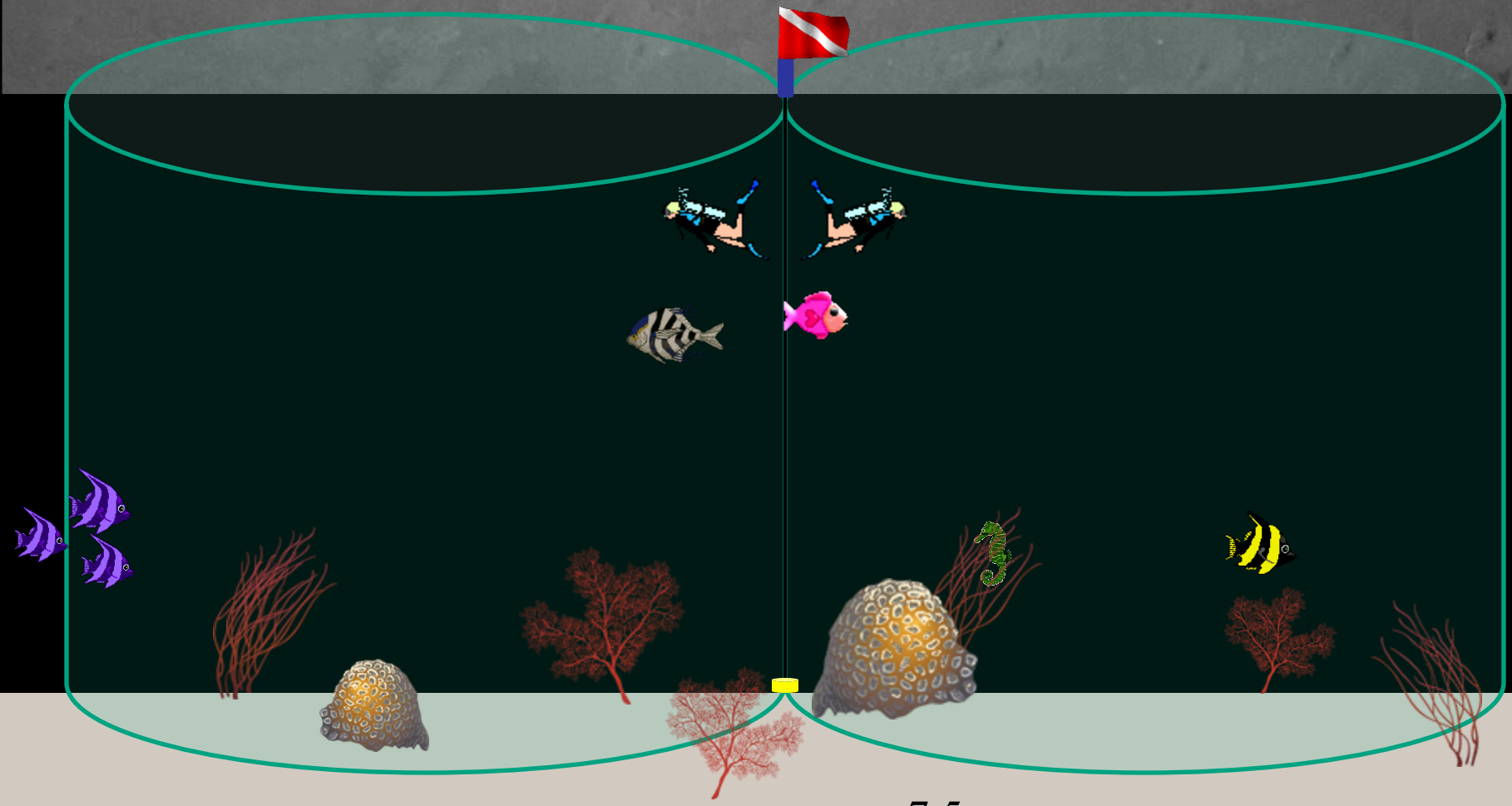
Data Collected:

- Showed >280 Species
- Included all fish life stages & sizes

Methods: Stratified Random



Stationary Point Counts



5 minute count

5 - 10 and >10 minute count

7.5 m

15 m

Fish Spawning Aggregation (FSA) in the Dry Tortugas

Lutjanus analis
mutton snapper

Mycteroperca bonaci
black grouper

Ocyurus chrysurus
yellowtail snapper

- What are the population dynamics of those reef fishes in the Dry Tortugas?
- Are there spawning migration patterns?
- What type of fish movement occurs between foraging grounds and spawning aggregation sites?
- How do fish use habitats of the reef environments and how long do reef fishes stay in the region?

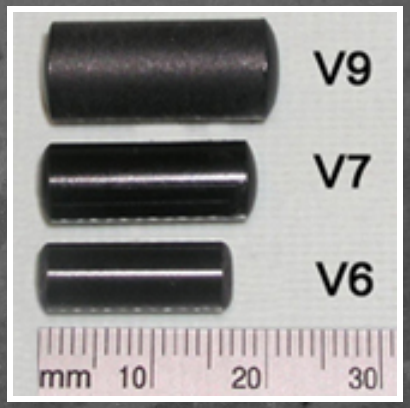
Fish Surgery???

Since 2008:

Yellowtail (18)

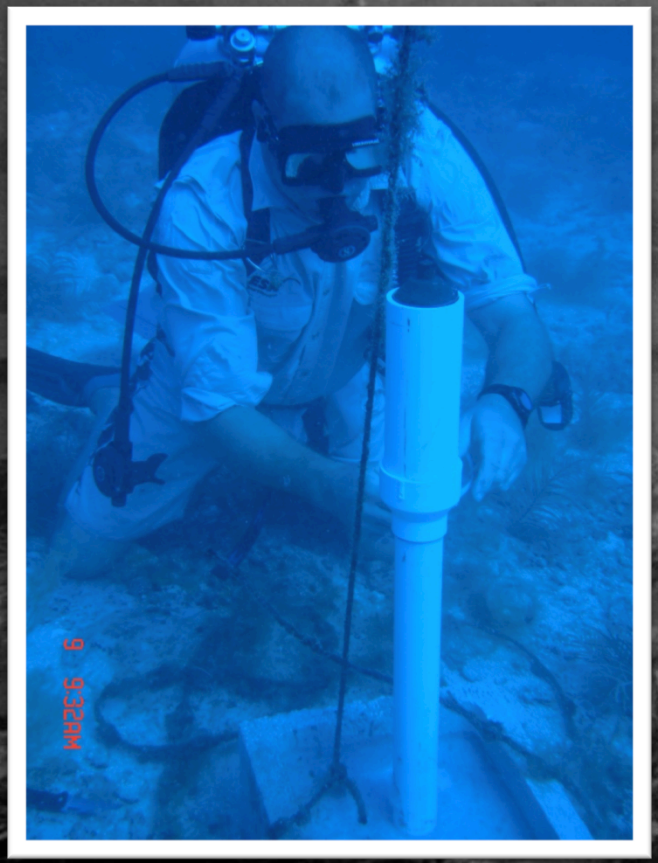
Mutton snapper (56)

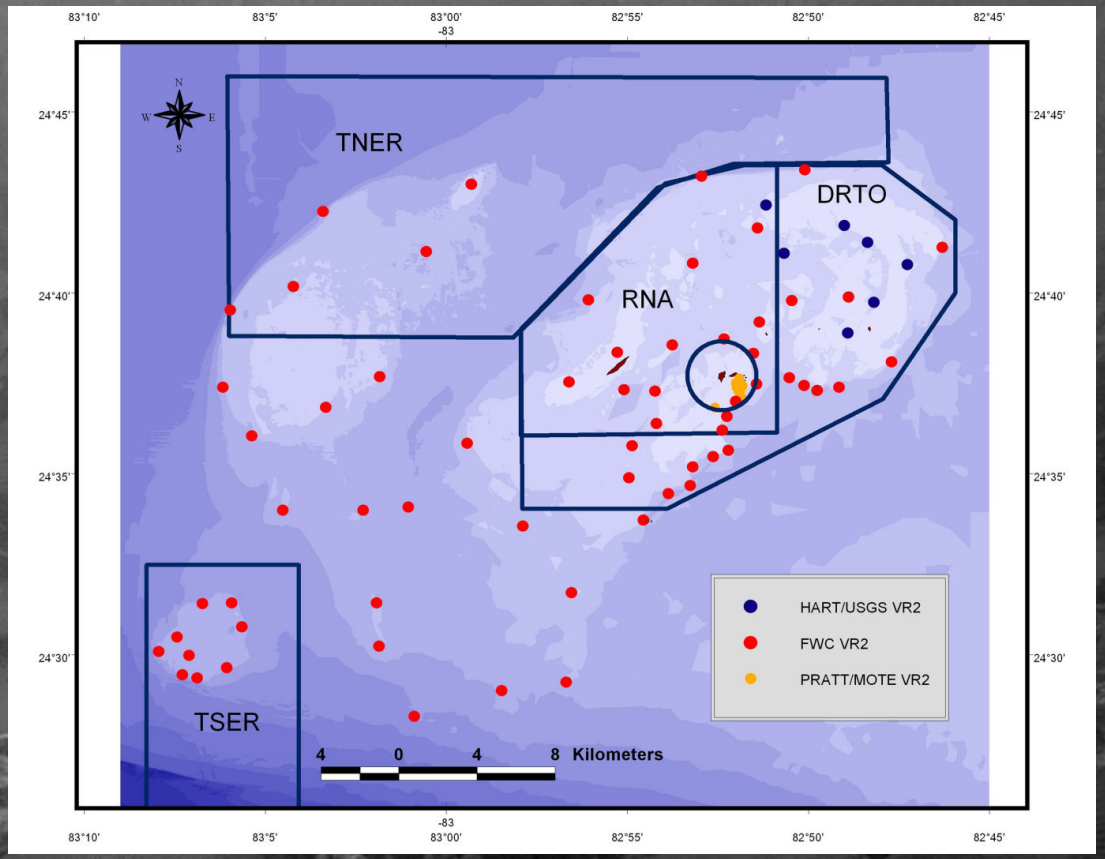
Black grouper (36)



FSA Work in the Dry Tortugas

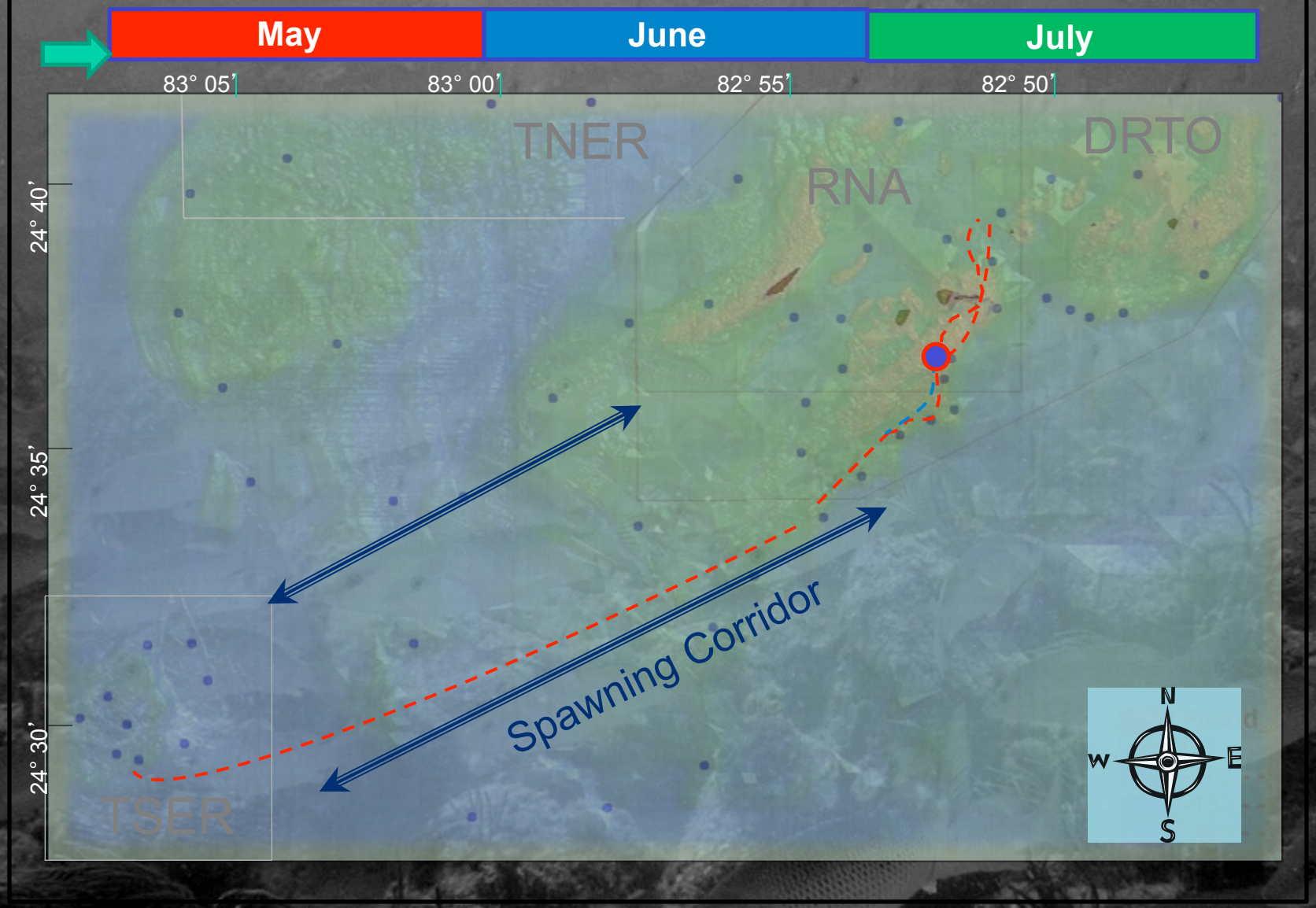
Scientists must dive to service receivers a couple times a year.

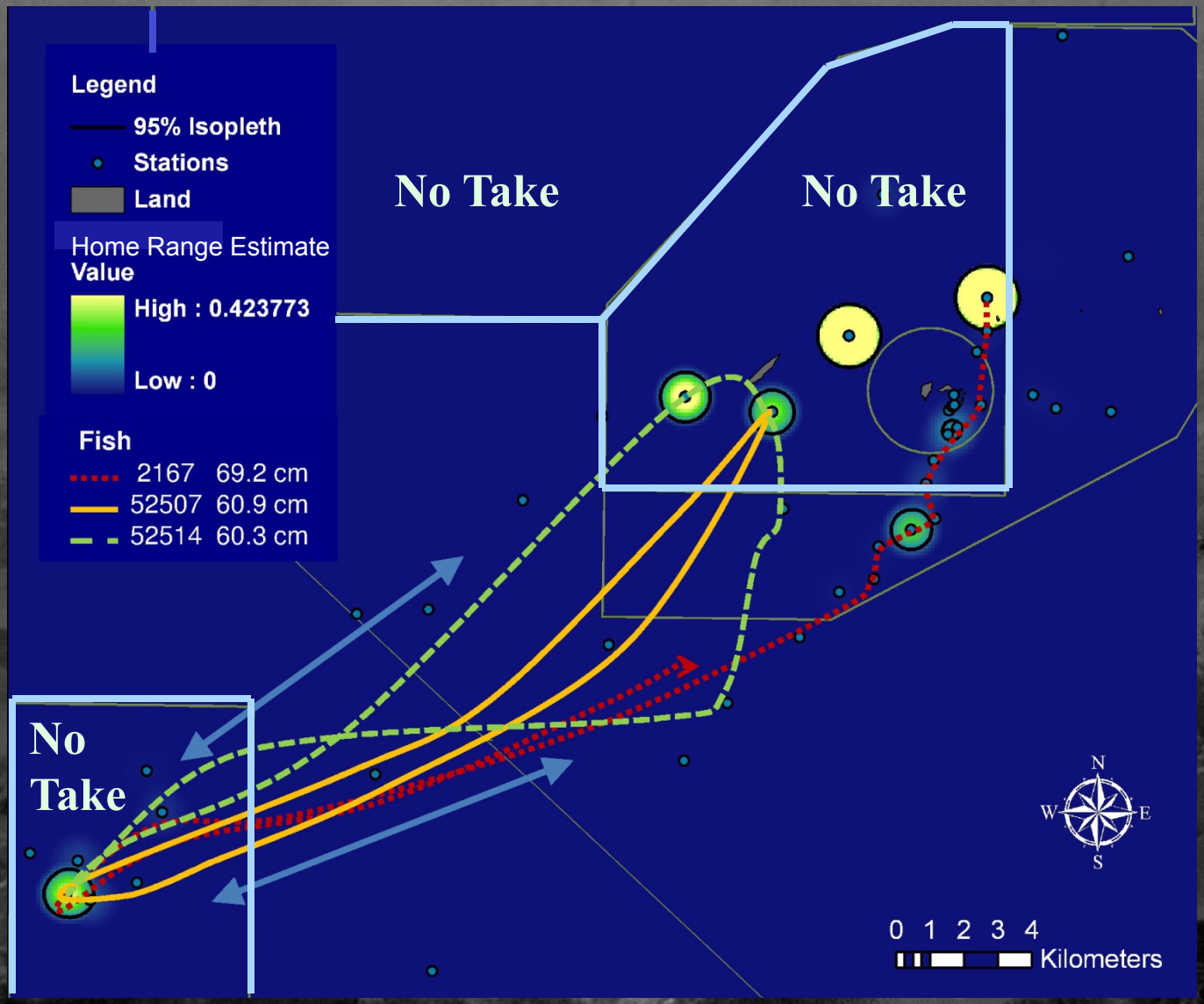




Sampling areas covered by the receivers included approximately 800km^2 and are comprised of varying habitats.

L. analis – 69.2 cm




Legend
95% Isopleth
Stations
Land
Home Range Estimate
Value
High : 0.423773
Low : 0
Fish
2167 69.2 cm
52507 60.9 cm
52514 60.3 cm
No Take
No Take
No
Take
N
W
E
S
0 1 2 3 4
Kilometers

Future Research…

- Marine scientists will continue to collect data to better understand the fisheries in the Florida Keys National Marine Sanctuary.
- The new information they gather will help policy makers better manage these natural resources.
- In the next class meeting, YOU will simulate the process used by scientists in the spawning aggregation study to add to their data set and make future recommendations to resource managers.